THE WHALE SHARK, *RHINEODON TYPUS* (SMITH)

BY

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(*With two plates*)

Several years ago, when visiting the 'shrine' of that great entomologist M. T. R. Bell at Karwar, I walked in on him just as he had finished reading one of my articles in the *Journal*. After the usual greetings, the old man turned on me jockingly and said, 'I don't believe you, McCann.' 'Don't believe what?' I replied, not knowing what he was referring to. 'What you have written.' The retort was spontaneous: 'It is the privilege of doctors and scientists to disbelieve each other—even themselves.' We understood and laughed heartily. This is the spirit in which I now write this short article on a 'monstrous' subject.

In a recent issue of the *Journal* (Vol. 51, p. 879) Dr. E. W. Gudger published an interesting article entitled, 'What ultimately terminates the life-span of the Whale Shark, *Rhineodon typus*?' I do not intend to answer this question, for I just do not know. However, there were certain aspects in the life of the Whale Shark which interested me. My limited experience with these giant fish and the views of some writers on the subject were not quite in accord. Having had occasion to cast one, and 'wallow' in the 'innards' of two young males landed in Bombay (1938 and 1940)[1] my hand flew to the hilt of my 'sword' on reading the above-mentioned article. But, I must confess that I feel diffident to cross swords with so great an authority on 'fishy' matters as Dr. Gudger. I merely question rather than attack.

The substance under the first sub-heading in Dr. Gudger's article, 'The only animate enemies of the Whale Shark—intestinal parasites', I must pass over; I found none—I did not look for any. However, the next sub-heading calls for some comment. Great size certainly reduces the enemy cycle of such animals that possess it, but it must be remembered that they all had small beginnings, and that the 'big fellows' only became big fellows at the expense of their less fortunate companions when they were all smaller and younger together! This is paralleled on land by the elephant which, in adult life enjoys a certain amount of immunity from predators. Perhaps, there is a weakness in my comparison for there is nothing known of the life-cycle of the aquatic giant in its infancy. However, some authors refer to schools of adults and, if this is true of the adults, there is good reason to believe that the young also band

[1] For a full account of these specimens see *JBNHS*, 42: 255.

together, just as many young fish do. All I intend to convey is that the predators take advantage of the giants during their early life and those that have reached the proportions of giants are comparatively immune from predators.

Turning to the second immunity factor referred to by Dr. Gudger, namely, the thickness and density of the skin, I can only rely on my experience with the two young specimens already referred to. The shagreen-covered skin was certainly tough to pierce with a large surgical scalpel but, once an incision was made, I experienced no difficulty in carrying on the cut. Incidentally, as is the case with most animals, the skin of the dorsal surface is somewhat tougher than that of the ventral. Speaking from memory, the tough outer skin was scarcely 3 to 4 mm.[1] thick (see plate IV). Below this tough envelope, cutting was easy. There was scarcely any difference between cutting through the skin of one of these giants and that of any big shark. To carry the comparison yet further, I have since had the opportunity of dissecting a Sunfish (*Mola mola*). The difference in the texture and toughness of the two is considerable. In the one instance it is like cutting through tough canvas, and in the other, through several layers of tough cardboard! Incidentally, I used the same knife on the two species. With the same scalpel, I got down to the heart without much difficulty. The heart is still in my possession. I have laboured this point just in order to show that these giants are not so tough as they appear to be. In the circumstances, I feel that the skin plays little, if any, part in protecting these monsters against well-armed predators. The giants, nearing maturity, have passed the stage of attack from their earlier enemies, just as adult elephants pass the stage of attack from large carnivora.

That mutilated specimens showing the attacks of predators are seldom, if ever, encountered or washed up is not surprising for, once the skin is torn, the flesh being comparatively soft, would soon be demolished by smaller flesh eaters and scavengers, in which the sea abounds. Accordingly, I agree that *size* plays an important part in survival, but not entirely. The effectiveness of the skin, as a protective armour is seriously open to question.

On the subject of food, Dr. Gudger believes that the Whale Shark is largely a surface-feeding plankton-gulper; of similar habit to the large baleen whales. Apparently, his belief is based on the observations of others, for, in support, he quotes Mr. E. R. F. Johnson: 'They (the sharks) were plainly engaged in feeding, swimming about for one or two minutes with the wide mouths partly open, the upper jaw being about even with the surface of the water. Then each fish would close its mouth and dive to a shallow depth, for the depth pressure to help to get rid of the water through the gills; and then the giant fish would come to the surface for another swim with mouth open.' Perhaps, this statement could be interpreted in quite another way. The opening and closing of the mouth was probably the normal 'fish-fashion' procedure of oxygenating the gills, and the occasional

[1] The puckered skin is well illustrated in the accompanying photograph.

sounding to accelerate the flow over the gills.[1] Such bulk, in spite of its sluggish habits, would require an enormous amount of oxygen to maintain itself. Accordingly, the original observation could be a misinterpretation, more so, as there are no stomach contents to support the statement. Again, I believe that surface plankton is comparatively scarce during the hours of daylight, and it is only at its maximum during the hours of darkness. However, depending on the season, there would be a considerable amount of drifting algae, with its attendant life, at the surface, which could be engulfed.

Towards the end of his section on the feeding habits of these giant fish, Dr. Gudger refers to reports from waters north of Cuba of Whale Sharks feeding in a *vertical position.* Again, a Mr. Stewart Springer had actually seen sharks feeding in the Gulf of Mexico in such a position. This posture during feeding, Dr. Gudger refers to as 'variant feeding'. Strangely enough, Dr. Gudger does not refer to the stomach contents of the only specimen which he had been fortunate enough to see in the flesh.

The two young males, which I had the opportunity of examining, were captured by fishermen in their nets and towed ashore. Neither of them was a diseased nor a disabled specimen. The stomachs in both the individuals were packed to capacity with marine algae. The algae were so fresh that there could be little doubt that the meal was very recent—the animals must have been feeding at the time of capture and blundered into the nets. Likewise, there can be little doubt that a certain amount of both micro- and macro-plankton may enter the capacious mouth along with the vegetation, but that is perhaps more accidental than deliberate. In the case of both individuals examined, no fish were observed among the stomach contents. This is all the more surprising when we consider that the animals were captured at the fishing grounds, and in fishing nets that were set for smaller fry. Under the circumstance it would not appear rash to conclude that the Whale Shark is predominantly a true vegetarian. Nevertheless, let us look further for some more evidence in support of this view.

A casual examination of one of these enormous fusiform giants seems to suggest that their shape has an important bearing on their manner of feeding. The greater bulk of their mass is concentrated towards the head, a factor of distinct advantage for sounding. Again, the terminal mouth would be of equal advantage whether they fed at the surface, or while sounding, in a vertical position as described by Springer.

The numerous rows of rasp-like teeth, quite unsuitable for holding active prey, seem admirably adapted for browsing on slime-covered algae. The closely pectinate gill-rakers, believed to be adaptations for sifting out the zoo-plankton engulfed while feeding, could be equally effective in expressing the water from the mouthful of algae. The gill-rakers would prevent the slimy laminae of the algae from getting among the gills themselves and, perhaps, fouling them. Speaking from memory, the gill-rakers appeared to be covered by

[1] In fish with subterminal mouths the action of the mouth would not be readily visible.

highly, vascular tissue and, besides performing the duty of a protecting sieve for the gill-chambers, is it not possible that they perform the function of ancillary gills also? However, this last point is an afterthought and requires confirmation.

We have still to explain the surface haunting habits so often observed. Both the young males were caught at night. This may suggest that the animals normally feed at night (?), and surface during the day, there to leisurely swim about, and bask in the sun, contentedly digesting the vast amount of algae eaten. Similar behaviour is met with among herbivorous land mammals, such as the ruminants, which feed by night and lie up during the day digesting their enormous meal of cellulose.[1] Another consideration which may not be out of place is that the surface water normally contains a higher volume of oxygen than the deeper layers; this fact alone would facilitate the respiration of such a monster and, at the same time, the warmer temperature of the surface and the procumbent posture would go a long way in aiding digestion of the vast meal. In addition, there appears good reason of believe that a herbivorous diet often tends to produce larger body form than does a carnivorous diet. This is equally true of the animals of the past as of the present day. Whales, however, seem to be the exception, but this exception may be largely due to the type of food (not herbivorous) and the manner necessary for capturing and feeding on such a diet. The head of a baleen whale is converted into an enormous 'trap', and the diet is rich. It is significant that the more aggressive and carnivorous cetaceans are also of small size.

Another feature of the Whale Shark, perhaps worthy of mention, is its apparently placid temperament. Apparently, this is also in keeping with its vegetarian diet. This too is paralleled by herbivorous land mammals. Not so long ago, I happened to see a film in which an aqualung diver had the courage to clamber over the head of a Whale Shark and to peer into its cavernous mouth. The shark did not seem in the least bit disturbed by this adventurous human. However, this is speculation, so let me pass on.

The habit of the Whale Shark of leisurely drifting at the surface has undoubtedly given rise to the widely accepted assumption that it is mainly a zoo-plankton feeder, but there is little or no evidence to support this view based on actual examination of the stomach contents. As early as 1870 Wright recorded large masses of algae as the stomach contents and he concluded that the animal was herbivorous. The repeated finding of large quantities of algae as the main stomach contents does not appear to be *merely accidental*!

Soon after reading the great epic of the Kon-tiki, I had the pleasure of meeting one of its crew, Bengt Danielsson. A passage from the book, dealing with the Whale Shark encountered, raised several questions in my mind and here was the chance of getting some of them cleared up. The passage is as follows: 'and a toad-like jaw which was four or five feet wide and had long *fringes hanging drooping from the corners of the mouth.*'[2] Were these *fringes*

[1] I am aware of the other factors involved also.
[2] The italics are mine.

algae? The behaviour of the animal, as described, appeared (to me) as though the animal were possibly feeding on the algae which had developed on the logs composing the raft. In reply to one of my questions, Mr. Danielsson informed me that quite a considerable amount of algae had formed on the logs. This then seems to be what the animal was after to have spent so much time about and under the raft. Evidently, it was browsing, and, perhaps, the *fringes* can be explained. If this were so, it seems we have some evidence that the animals feed on algae drifting at or near the surface. Mr. Danielsson confessed that *he* was not very pleased with the proximity of the great beast at the time, in spite of its placid nature!

A further argument that these sharks are vegetarians centres round their seasonal migration, particularly their periodicity and location along the coasts of India. Writers on the Whale Shark have gone to some length to account for the movements of these fish in relation to the appearance of off-shore phyto- and zoo-plankton, and the trend of ocean currents. Although these factors play an important indirect part, the main seasonal movement appears to be coupled with the first two principles of life—*preservation* (feeding) and *procreation* (breeding). Either one or both factors may cause animals to change their immediate habitat. This is common to most life in the broader sense, and is well known. However, it often happens that in our enthusiasm to fathom the unknown we lose sight of the obvious! This reminds me of a story told me by a French biologist. A professor was making an exhaustive study of the uses of the leg. After considerable research, he went in great glee to his colleague and said, 'Professor! Professor! I have discovered forty-nine uses of the leg.' 'Let me see,' said the other. After perusing the list, he turned to his companion and said, 'Ah! but, my dear colleague, you have forgotten one'. 'Which one?' came the sharp reply. 'The *natural* one—walking!'

I do not intend to deal with this aspect of the Whale Shark's life-cycle in great detail, but merely to make brief references to some of the more probable factors controlling its movements, as they present themselves to me. My observations are based mainly on the belief in the vegetarian diet of these great fish. Their appearance along the Indian coasts, particularly along the western coast, between certain months of the year (January to April) seems to be very significant. It coincides with the annual increase of the algal vegetation along the coastline. That the trend of oceanic currents at that particular season of the year influences and assists migration, goes without saying, but it appears to me that the main influence is the abundance of marine algae (food). At the time when the fish are moving westward (January to April), the Bay of Bengal is under the influence of the north-east monsoon. The great rivers emptying into it carry down enormous volumes of freshwater and sediment in suspension. The sediment in suspension may be seen far out at sea. The dilution of the waters of the Bay and the large amount of sediment are factors detrimental to the growth of marine algae. Hence, food is scarce, and there would be no incentive for the animals to travel up the Bay, apart from the muddy condition of the

Photo: J. T. Salmon

Courtesy Dominion Museum Wellington, N.Z.

The Basking Shark (*Cetorhinus maximus*)

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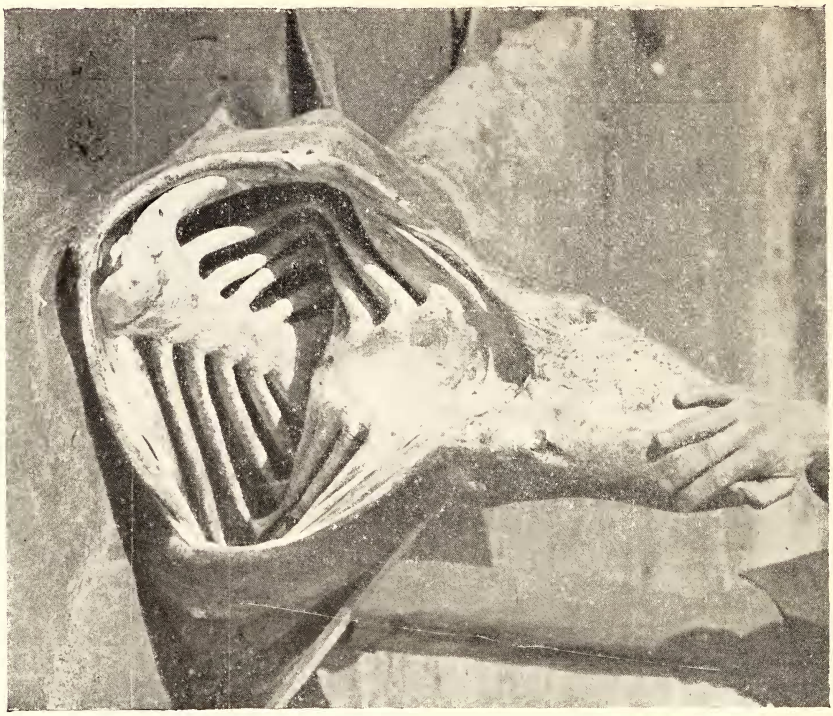

A. Showing gill arches and reduced tongue.

Photos: J. T. Salmon *Courtesy Dominion Museum Wellington, N.Z.*

B. Gill arch with gill and gill rakers.

water and lower density. That an occasional stray may enter the upper reaches of the Bay in no way negatives this conclusion.

When the north-east monsoon is in progress, the western coast of India is normally free from heavy rain. Excepting the Indus, no large rivers empty into the Arabian Sea. Soon after the cessation of the south-west monsoon, which brings heavy rain to the west of India, the coastal waters clear, and there is a marked increase in algal production. The inter-tidal zones are remarkably productive, and large quantities of the algae are swept out to sea by wave and tidal action. There is a corresponding increase in the deeper water forms during this period. About March, each year, the inter-tidal algae commence to die out. By May, the monsoon swell commences and the sea often becomes boisterous and churns up the coastal waters.[1] This action of the sea, shortly to be followed by the monsoon rains, coupled with the sediment in suspension, reduces the amount of the deep water algae. Thus again, there is a scarcity of food and the sharks move off to 'greener' pastures.

In Vol. 42, p. 255 of the *Journal*, Mr. S. H. Prater gives us an informative article dealing with the distribution of the Whale Shark in the Indian waters. The article is well illustrated and worthy of careful perusal. Mr. Prater goes to some length in an effort to explain the seasonal migration of these animals and arrives at the conclusion that their movements are dependent on the movements of oceanic currents and zoo-plankton. This conclusion is mainly based on the assumption that the Whale Shark is largely a zoo-plankton gulper. His view is all the more surprising when he was fully aware of the stomach contents of the 1938 and 1940 specimens, and of the circumstances under which they were captured. In addition, he was also aware of Wright's evidence. Surely, the stomach contents of these individuals were not accidental? The evidence that the Whale Shark is a zoo-plankton feeder is, to say the least, very slender.

I am not familiar with the Basking Shark, *Cetorhinus* (see Pl. I) but from the numerous accounts of the species and some of its anatomical characteristics, it would appear that there is little doubt that it is a zoo-plankton feeder, subsisting largely on shrimp-like crustacea (krill) and other small organism, just as the baleen whales do. The similar habit of drifting or swimming at or near the surface observed in both the Basking and Whale Sharks has, apparently, led to the assumption that the feeding habits and the food are similar, if not the same, in the two species. This assumption I am not prepared to accept for several reasons, not to mention the stomach contents already referred to. In support of my 'disbelief', allow me to compare the two in several details:

(*a*) *Shape*[2]:—If we contrast the shape of the two species it will be noticed that *Cetorhinus* (Pl. I) is far more fusiform and stream-lined than *Rhineodon*. The bulk of the former is more evenly distributed throughout its length than in the case of the latter.

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[1] It is generally believed that sharks are averse to entering turbid water.

[2] The illustrations depicting the shape of *Cetorhinus* in many works are not in strict keeping with its actual shape (i.e. line drawings)!